AN IMPROVED METHOD OF BRAIN LOCALIZATION IN EPILEPSY.[1]

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IT seems to be nothing but germain to our pathological views that a disease which is so well characterized by its specific symptoms as the so-called idiopathic or genuine epilepsy should have its detectable morbid substratum. Still, only recently have investigations, and prominently those of Van Gieson, thrown some light on such cases, that heretofore have been wrapped up in the mysterious cloak of purely functional morbidity. The difficulty is that it takes an expert microscopist to detect the tissue changes, and that the examination has to be made during the operation unless it should be preferred to operate in two stages. But aside from the idiopathic form of epilepsy, and even then when gross changes are present, the correct determination of their seat and extent is not always easy. For I think there is no doubt that while epilepsy is only a symptom of very different diseases of the brain, and perhaps the spinal marrow, it will in most cases be only a certain circumscribed portion of those central organs where the morbid changes have taken place. It is consequently of the highest importance to the surgeon to get an indisputable method of mapping out the diseased area, because only then will he be able to decide whether a radical operative undertaking is feasible and justifiable or not. The brilliant discoveries of the physiologist and neurologist have presented the surgeon with a firm base for his action, and the wonderful ease with which we now localize, in a great many cases, the field where the morbid changes have

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to be looked for, makes it an easy task to find the pathological evil-doer. A large bone flap is raised, sight, touch, puncture and other known means are used, and in many instances even the tyro will find his way.

Still, no experienced surgeon will be satisfied with the present diagnostic methods. There are too many cases where all those means fail to disclose the real trouble, and still more, perhaps, when not enough of the cortex is removed from not knowing the real extent of the morbid tissue. The great number of failures to effect a permanent cure are only partially due to consequent cicatrization or to adhesions; the greater number are to be ascribed to our inability to find and correctly estimate the diseased part. Because even the seemingly unfailing topographical, as well as the electrical, methods of localization, do not protect against mistakes. They may even lead astray. It is the object of my paper to prove the correctness of such a view, and to propose a method for consideration which promises to make localization of the diseased brain focus safe and extremely simple. In pointing out some of the sources of the difficulties, mistakes and errors in the present methods, I first would mention untoward outside circumstances. For instance, wanting opportunity to witness the initial signal, erroneous statements of the patients or of their relatives, etc. In the "Reference Handbook of the Medical Sciences," there may be found so excellent a survey of these things, given by Professor Keen, that I may abstain from further discussion.

Secondly: A great number of brain foci are not yet discovered, and as presumably all peripheric muscles and all extracerebral ganglia are in some way connected with brain centres, all the former can be set into epileptic action by disorders of the latter. But not knowing these connections, and not having paid sufficient attention to the more hidden signals—for instance, such as in the generative or alimentary or uro-poietic organs—the commencement of the convulsion will easily be ascribed to a better known and more exposed group of muscles in the face or extremities, which may have become excited only secondarily by the dissemination of the epileptic wave started somewhere else, and

consequently a wrong brain focus will be singled out and perhaps operated on. It will have struck everybody, for instance, how often abnormal sensation or motion occurs in the stomach or in the intestines as the first sign of an attack; there may be nausea or vomiting or only a strange feeling. Still, we are in the habit of watching for a twitching or a contraction of some muscle in the face or hand or arm, and may fail to recognize the real initial signal altogether. Of course the removal of a thus falsely located focus will do no good.

Thirdly: The brain foci are, as we know, not strictly defined localities; they are interlocking and overlapping each other. Thus the same diseased point may stand in close relation to the functions of two or more groups of muscles, and therefore cause very mixed convulsions. The same condition may be caused by the extension of the same pathological process over or into various adjoining foci, as evidently the area of pathological changes is not defined by its physiological character. Under such circumstances the initial signal may be given by different sets of muscles simultaneously, or the same muscles may act promiscuously, once sooner, the other time later, than the others.

Fourthly: The topographical as well as the electrical localization does not locate the seat of the morbid process. They both only map out the physiological focus belonging to a certain group of muscles. If this focus be removed, the circuit will, no doubt, be broken; and even if it was not, the diseased portion of the brain, the epilepsy, as far as these muscles go, will cease, and perhaps even entirely, at least for some time. Because it is a known fact that almost any surgical interference will exert a temporary beneficial influence upon the disease. But it will return sooner or later, for the real evil-doer will persist to exert its vicious influence and will most likely find another victim to prey on. The question whether the focus belonging to a certain epileptic process is always diseased itself, or whether it is not frequently only secondarily irritated by another diseased portion of the brain that stands in a topical, anatomical or physiological relation to the former, looks at the first glance almost foolish. Still, if we consider that the removal of a chip of bone or of a

depressed piece of the skull, or of a cyst or an abscess, will at once stop the abnormal action of an underlying or adjoining focus, then it appears to be evident that this latter was not the seat of the trouble, but that it only was induced to act perversely by the irritation of a foreign substance. Of course, it is possible that the focus acted upon had been naturally excessively irritable, though within physiological limits; or that it, by the long-continued vicious influence it had to endure, became unduly irritable; still, even then it would not act epileptically without the particular provocation of the existing foreign body. Now, there is no reason why a densely cicatrized, or a gliomatous or a sclerotic plug should not act exactly like a foreign body. Seen in this light, there are then two possibilities before us; either a focus is so diseased that it will functionate viciously on certain biological provocations, or a healthy focus becomes so irritated by a diseased neighbor as to act epileptically on certain unknown occasions. The first modus can be surmised either when the pathological changes are confined only to one part of the focus, the balance remaining healthy, so that the diseased part will act as the foreign body on the balance; or when the morbid alterations are not sufficient to interfere with the specific compound work of the cell cluster, perhaps only a small number of the cells or only one of the layers of the cortex being out of order; because, if the whole focus were totally degenerated, then, from all analogy with other pathological experiences, there would be no functionating at all, either normal or abnormal. We are as little entitled to expect a specific energy from a disorganized piece of gray matter as to expect a specific energy from a degenerated gland. As to the second condition, namely, that a physiological centre is so irritated by a diseased neighbor as to act epileptically, it is too obvious that little good can come from the removal of the former.

From all such considerations, we must confess that the present methods of detecting the real seat of the disease are not sufficient unless the pathological changes are plainly seen or felt. As soon as the surgeon has to depend upon topographical or electrical localization alone he may be misled, because he is only

striving at the mapping out of the physiological focus of the muscles that have given the initial signal. But there is, as can be concluded from the explanation given, no proof that this focus really is the diseased portion of the cortex. Besides, such methods are no guides as to the extent of the disease; it is left to chance whether enough or too much be removed. If, though, my proposition, which has given full satisfaction in two cases, should turn out to be what it has promised, then all difficulties would be removed at once. *My advice is to use the induced current not solely to find the physiological focus belonging to the muscles giving the initial signal, but to find the spot from where an epileptic attack of the same nature the patient is accustomed to suffer from can be started, independently of the fact whether those two points coincide or not.* Under this rule it is not necessary at all to be so very scrupulous in localizing the part to be attacked before the operation, although there is no objection to it. It will be desirable to lift up a large bone flap over the presumable field so as to get a wide area accessible to examination. If no definite recognizable changes sufficient to explain the trouble are found, the electrodes, as devised by Keen (two wire points about ¼ to ½ inch apart), should be extensively applied over the whole area. When the place from which epileptic convulsions can be elicited is hit, the experiment should be repeated so as to leave no doubt about it. If exsection should have been decided upon, the current has to be applied to the borders of the brain wound again and again until epileptic symptoms can no longer be produced, in order to rest assured that every particle of diseased tissue has been removed. It is possible that more than one epileptic centre or focus exists; of course in that case all of them ought to go if the patient is to be relieved of his epilepsy.

Now, the objection may be raised that a strong current may irritate healthy cortex so much as to throw the patient into an epileptic fit. Then the proposed test would obviously lose all its value. But according to Ferrier's experience it takes a prolonged, often repeated electrical abuse of a monkey's brain, at least, to render him epileptic. Healthy cortex does not respond to electrical irritation by epileptic convulsions. It must

not be forgotten that electricity is by no means the natural physiological force in nerve action. It is nothing but a very energetic stimulus, but perhaps not even as powerful as heat, cold, chemical influence, and so on. It seems but natural, then, that it should stimulate a certain cell to its specific energy and to nothing else. If, therefore, this specific energy of a brain focus is to cause contraction of a certain set of muscles, then upon electrization, such and no epileptic fit will follow, which is certainly an entirely different thing. On the other hand, if diseased tissue has acquired the morbid force necessary for the production of epilepsy, it will exert this, its vicious influence, as soon as it is stimulated, either by electricity or any other irritating force. It is certainly not plausible that the nerve-cells should have to produce as much of an electrical force as our powerful machines in order to affect each other or to set the depending musculature in action. It is astonishing what an immense strength of current is sometimes needed to produce even the slightest physiological peripheral effect from cortical electrization, while the slightest touch of the electrodes will at once produce a regular fit when applied to the right spot.

Another objection, that the proposed use of the current may afterwards turn out to be injurious to the brain, can be dismissed, too. All experience speaks against it. I, for myself, can state that even prolonged use of the galvanic current, even of a strength of 20 to 30 milliampères, and repeated daily for many months, had not only no unwholesome, but, on the contrary, a very beneficial effect upon the functions of the brain.

There is, then, no excuse for not trying to arrive at a reliable information about the real location of the morbid tissue in epilepsy by the use of extensive and, if necessary, repeated application of the induced current. We need not be afraid to throw the patient into two or more attacks while he is on the table.

In support of my views, I present the histories of three cases. It is not much I have to offer. The operations, though, have been witnessed by several medical men and closely and critically observed.

The first history proves, in my opinion, that a perfectly degenerated piece of cortex, not exerting any function itself, may cause a neighboring piece to act epileptically. The second case shows that a diseased focus may render a sound neighbor epileptic without causing its own depending musculature to give the initial signal.

The second operation on the first-mentioned patient confirms this supposition. The two last operations show, besides, beautifully the value of the proposed method in the detection of the diseased brain tissue. There was no doubt left in the minds of the witnesses regarding the correctness of the discussed test, at least in these two cases.

CASE I.—H., a stout German laborer, thirty years old, was taken with his first fit when sixteen years old. He attributes it to a sudden scare; did not receive any injury. The signal is given by the muscles of the neck, which get drawn to the right, after which general convulsions of extreme severity spread over the right, and from there to the left side. He has taken medicines for many years, was trephined a year ago and had submitted to direct cerebral galvanization. Got relief from the latter for some months, after which time the old condition set in anew. He was then operated on in St. Mary's Infirmary, with the kind assistance of the surgical staff. In about the posterior and inferior corner of the corresponding focus a yellow spot of the size of a nickel was easily made out. It was removed and the wound treated by iodoform gauze, etc. *There was not the least amount of paralysis of any muscle to be detected, while the epileptic attacks stopped at once.* After several months of perfect relief a somewhat different form of epileptic spells developed gradually. They were attributed to adhesions and perhaps to too large an opening in the skull, which annoyed him greatly. The spells were more of a general disseminated character; according to his statement there was a good deal of permanent dulness and aching of the brain. Unfortunately, no spell was seen by an intelligent observer, so that I had to depend a good deal upon the patient's own description and that of his companions.

CASE II.—B., a boy of about eighteen years, had a fall and brain fever (?) when six years old. Signal is given by twitching in the left wrist, which also, in the intervals between his attacks, feels

dull and deadened. Retina blurred, but no choked disks. Diagnosis: Most probably a cyst.

H. was trephined a year ago without any benefit to him. The second operation (June, 1893) consisted in a free enlargement of the trephine hole and incision of the dura. The cortex looked engorged, the veins much distended over a large area. A spot behind and on a level with the middle of Roland's fissure was of almost a black color. Right under this spot palpation detects a kind of a yielding hollow place. An incision reveals a narrow, deep cavity. The circumference of this incision, representing the mentioned dark spot, is excised. Now, what was of the utmost interest was the response of the different portions of the cortex to the induced current. They mostly reacted slightly physiologically, causing the depending muscles to twitch and contract, or not at all; but the black spot responded promptly by a regular epileptic fit, whose initial signal, though, could only generally be located in the left hand and wrist, the observer having been overcome with surprise.

When the patient came out from the chloroform, the wrist was found free from the previous sensations, had perfectly normal mobility and sensation, but the thumb was absolutely paralyzed. The patient had a rapid and perfectly satisfactory recovery until, in the fifth week after the operation, he received a terrible blow against his head. He died from general encephalitis without having had another epileptic attack. Here the centre of the thumb was evidently the principally diseased piece of cortex, but the intermixed and adjoining centre for the muscles of the wrist was the one that had always given the signal.

CASE III.—The patient whose history was first given was resubmitted to operation only four days ago, as his fits gradually became severer. The object of this last operation was mainly to break up supposed adhesions and to close the large cranial opening. There was found a thickened dura, and between it and the cortex dense adhesions over an area of about three inches in diameter. There was a well-marked depression in the cortex, corresponding to the exsection done in the first operation. The induced current now applied, even with such strength as not to be endured by my fingers, produced no contraction in any peripheric muscles, but as soon as the electrodes were applied to a spot corresponding to a portion of the focus for the hand and forearm, a regular epileptic spell, starting in the hand and extending in Jacksonian manner over the whole side, was easily elicited as often as the experiment was repeated.

This point was the direct continuation of the area which was excised at the first operation, recognizable by the mentioned depression. There was nothing further done, as I did not feel justified in paralyzing the man's arm and hand without his consent.

In this case evidently not enough was removed in the first operation, in which no current had been used for localizing purposes. Abstaining from all speculations on mistakes that may have been made in localization, diagnosis and surgical procedures, and how much adhesions could have had to do with the recurrence of the epileptic convulsions, I claim that the case is a strong proof of the great and almost absolute value of the proposed test in mapping out the location of the diseased cortex.

Additional Note.

After having read my paper before the Southern Surgical and Gynæcological Association, November 15, my attention was called to an article in the *British Medical Journal* of the fourth of the same month, wherein Professor Sherrington, of London, gives the history of a most interesting case, which is so similar to one of mine, and where some points made are so much in conformity with the views I had expressed, that I take the liberty to append a short abstract of it: A boy of fifteen years has four to fifteen attacks daily. They start with a tickling sensation in the sole of the right foot, followed by contraction of the great toe, extension of the ankle and flexion of the knee; occasionally slight flexion of the fingers. Trephining just behind Rolando's fissure. The cerebral substance at the lower part of the exposed area looked discolored and was freely excised. No improvement followed. Second operation: The former opening was enlarged and the electrodes applied to the cortex. No response was produced on stimulating the lateral and posterior part of the exposed surface, but on applying a strong current just above the part previously removed, movements of the foot and knee similar to the epileptic spasms were produced. After one or two stimulations a typical clonic spasm was produced, which lasted after the withdrawal of the electrodes. The area by stimulation of which these movements were produced was about the size of a sixpence and was situated just above the discolored area previously removed. It was freely excised to the depth of three-fourths of an inch. There was

no loss of power in the right leg or foot, and no impairment of any movement, etc., but there were some slight attacks of clonic spasm of the arm, chin, shoulder, etc., without any participation of foot or leg. He steadily improved, and for the last two months (about eighteen months after the second operation) he has, during the early hours of the evening, one or two slight attacks of contractions of the muscles of the right thigh and hip-joint, which often do not awaken him. He does not lose consciousness. The statement is made that in the portion of the cerebrum excised at the first operation, which was examined microscopically, the discoloration was found to be due to "altered blood," but that nothing abnormal was detected in the part removed in the second operation. I do not know whether the examiner was familiar with Dr. Van Gieson's microscopical methods and discoveries. But conceded even that nothing pathological could be found, the salient point that not even gross changes, and so much the less topographical and electrical localization, will serve as reliable guides in the discovery of the real source of the trouble, while the excitation of a veritable epileptic fit will do so is clearly shown. The perfect failure to produce muscular action by even the relatively strongest currents applied upon the cortex, surrounding the epileptic zone, is explained, in part at least, by having struck one of the inexcitable blanks first observed to exist in the motor area of man by Lloyd and Deaver, and in the ourang by Beevor and Horsley. In my opinion, though, this explanation can hardly be accepted; because the extent of inexcitable cortex, from my own experience and that of others, would be much too large; in fact, it would sometimes comprise the whole exposed surface with the exception of a very limited epileptic spot. I think that in Professor Sherrington's case the morbid changes extended over the portions removed in the first and in the second operations; and that if the current had been used in the first one epileptic response would have been elicited from the first excised portion as well as from the one removed in the second operation. The persistence of slight epileptic symptoms may be due to a diseased portion left behind, which would have been detected by applying the current again after the excision.

In Professor Sherrington's article reference is made to a history of another case, reported by Professors R. Parker and F. Gotch, of Liverpool, in the same journal, of May 27. Here the initial signals could not be made out in a definite way, but the foci of the thumb and wrist were finally settled on as the ones most likely at fault.

They were mapped out by topographical, and in the operation by electrical, localization. (Again the enormous strength necessary to produce muscular contractions startled the operator.) Patient kept on having from six to forty spells a day, though he improved somewhat further on. Now, the electrodes were applied on four places, all of them, though, in front of the fissure of Rolando. The two uppermost points were found to be the foci wanted, and were excised. The failure of the operation seems to me easily explained by the failure in the detection of the real seat of the disease. Had the electrodes been applied to a larger area, and, before all, to the cortex behind the fissure, the spot from which a *real epileptic fit* could have been started, would likely have been found, and upon its removal a better condition would have been obtained.

I concede that my idea is not yet sufficiently verified by experience, but I think it is worthy of consideration and of an unbiased trial.